

CLAIMS

1. A method of forming a cationic electrodeposition film, comprising immersing an article to be coated, composed of a
5 galvanized steel sheet, into a bath tank filled with a cationic electrocoating liquid containing a base resin and forming an electrodeposition film on the surface of said galvanized steel sheet by current-carrying,

wherein an electric through hole is formed within said
10 film to secure the conductivity of said film in order to wipe out a spark discharge phenomenon arising due to the presence of a hydrogen bubble produced through cohesion of hydrogen gas, with the passage of time, generated by said current-carrying at a gap of the film, which develops in depositing/forming the
15 film by said current-carrying and increasing its thickness with the passage of time, on the surface of said galvanized steel sheet, and

thereby an increase in an electric resistance value
($\text{k}\Omega \cdot \text{cm}^2$) per unit weight (mg) of said film is inhibited.
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2. The method of forming a cationic electrodeposition film according to Claim 1,

wherein a component composing said film comprises said base resin, said base resin is an amine-modified epoxy resin
25 and said electric through hole is formed by locating an acid group ($-\text{COO}-$) in the vicinity of an end amino group of said amine-modified epoxy resin.

3. The method of forming a cationic electrodeposition film
30 according to Claim 2,

wherein the acid group ($-\text{COO}-$) is a product of a reaction of an acid anhydride and an amino group.

4. The method of forming a cationic electrodeposition film
35 according to Claim 1,

wherein said electric through hole is one formed by locating an acid group derived from a resin containing an acid group, which is poorly soluble in water.

5 5. The method of forming a cationic electrodeposition film according to Claim 1,

 wherein said electric through hole is one formed by locating an acid group derived from an amphoteric ion group-containing resin.

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 6. A method of forming a cationic electrodeposition film, comprising immersing an article to be coated, composed of a galvanized steel sheet, into a bath tank filled with a cationic electrocoating liquid containing a base resin and forming an
15 electrodeposition film on the surface of said galvanized steel sheet by current-carrying,

 wherein a spark discharge phenomenon in a hydrogen bubble on the surface of said galvanized steel sheet is inhibited by controlling an increase in an electric resistance value ($k\Omega \cdot \text{cm}^2$)
20 per unit weight (mg) of the film deposited/formed by said current-carrying.

 7. A method of forming a cationic electrodeposition film, comprising immersing an article to be coated, composed of a
25 galvanized steel sheet, into a bath tank filled with a cationic electrocoating liquid containing a base resin and forming an electrodeposition film on the surface of said galvanized steel sheet by current-carrying,

 wherein an electric resistance value ($k\Omega \cdot \text{cm}^2$) per unit
30 weight (mg) of the film deposited/formed by said current-carrying is 1.0 or less within 4 seconds after said current-carrying is initiated and 2.0 or more after a lapse of 10 seconds after said current-carrying is initiated.

35 8. A method of forming a cationic electrodeposition film,

comprising immersing an article to be coated, composed of a galvanized steel sheet, into a bath tank filled with a cationic electrocoating liquid containing a base resin and forming an electrodeposition film on the surface of said galvanized steel sheet by current-carrying,

5 wherein an increase in an electric resistance value ($k\Omega \cdot \text{cm}^2$) per unit weight (mg) of said film is suppressed for 4 seconds from the initiation of current-carrying in order to wipe out a spark discharge phenomenon arising due to the presence
10 of a hydrogen bubble produced through cohesion of hydrogen gas, with the passage of time, generated by said current-carrying at a gap of the film, which develops in depositing/forming the film by said current-carrying and increasing its thickness with the passage of time, on the surface of said galvanized steel
15 sheet.

9. The method of forming a cationic electrodeposition film according to Claim 7 or 8,

wherein said current-carrying condition is a manner in
20 which voltage is elevated at a constant rate in a condition of selecting 5 seconds as a duration until reaching a predetermined applied voltage and

in this condition a temperature of a bath liquid is 20 to 40°C during coating,

25 a concentration of non-volatile matter of a bath liquid is 15 to 25 % by weight during coating,

an area ratio between an article to be coated and an electrode is 1:1 to 2:1 and a distance between electrodes is 15 cm.

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10. A cationic electrocoating composition containing a base resin

which can secure the conductivity of a film by forming an electric through hole within a film deposited/formed by
35 current-carrying during cationic electrodeposition process,

and inhibit an increase in an electric resistance value ($\text{k}\Omega \cdot \text{cm}^2$) per unit weight (mg) of said film.

11. The cationic electrocoating composition according to
5 Claim 10,

wherein a component composing said film comprises said base resin, said base resin is an amine-modified epoxy resin and said electric through hole is formed by locating an acid group ($-\text{COO}-$) in the vicinity of an end amino group of said
10 amine-modified epoxy resin.

12. The cationic electrocoating composition according to Claim 11,

wherein the acid group ($-\text{COO}-$) is a product of a reaction
15 of an acid anhydride and an amino group.

13. The cationic electrocoating composition according to Claim 10,

wherein said electric through hole is one formed by
20 locating an acid group derived from a resin containing an acid group, which is poorly soluble in water.

14. The cationic electrocoating composition according to Claim 10,

wherein said electric through hole is one formed by
25 locating an acid group derived from an amphoteric ion group-containing resin.

15. A cationic electrocoating composition
30 which can control an increase in an electric resistance value ($\text{k}\Omega \cdot \text{cm}^2$) per unit weight (mg) of a film deposited/formed by current-carrying during cationic electrodeposition process.

16. A cationic electrocoating composition
35 which can render an electric resistance value ($\text{k}\Omega \cdot \text{cm}^2$)

per unit weight (mg) of a film deposited/formed by
current-carrying during cationic electrodeposition process 1.0
or less within 4 seconds after the current-carrying is initiated
and 2.0 or more after a lapse of 10 seconds after the
5 current-carrying is initiated.

17. A cationic electrocoating composition
which can suppress an increase in an electric resistance
value ($k\Omega \cdot \text{cm}^2$) per unit weight (mg) of a film for 4 seconds from
10 the initiation of current-carrying in order to wipe out a spark
discharge phenomenon arising due to the presence of a hydrogen
bubble produced through cohesion of hydrogen gas, with the
passage of time, generated by said current-carrying at a gap
of the film, which develops in depositing/forming the film by
15 current-carrying during cationic electrodeposition process and
increasing its thickness with the passage of time.

18. The cationic electrocoating composition according to
Claim 16 or 17,
20 wherein said current-carrying condition is a manner in
which voltage is elevated at a constant rate in a condition of
selecting 5 seconds as a duration until reaching a predetermined
applied voltage and

in this condition a temperature of a bath liquid is 20
25 to 40°C during coating,

a concentration of non-volatile matter of a bath liquid
is 15 to 25 % by weight during coating,

an area ratio between an article to be coated and an
electrode is 1:1 to 2:1 and a distance between electrodes is
30 15 cm.